**Online Advertising Performance Analysis of Company X**

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**Introduction**

This analysis explores the online advertising performance of Company X from April 1, 2020, to June 30, 2020. The dataset includes various metrics such as ad displays, clicks, cost, revenue, and post-click conversions. The goal is to understand trends, correlations, and effectiveness across different aspects of the advertising campaign.

**Question and Solution**

Question 1: What is the overall trend in user engagement throughout the campaign period?

user\_engagement\_trend = df\_cleaned.groupby(['date', 'user\_engagement'])['displays'].sum().unstack().fillna(0) print(user\_engagement\_trend)   
plt.figure(figsize=(12, 6)) user\_engagement\_trend.plot(kind='line', marker='o') plt.title('Overall Trend in User Engagement')   
plt.xlabel('Date')   
plt.ylabel('Number of Displays')   
plt.legend(title='User Engagement')   
plt.grid(True)   
plt.show()

Question 2: How does the size of the ad (banner) impact the number of clicks generated?

banner\_clicks = df\_cleaned.groupby('banner')['clicks'].sum() print(banner\_clicks)   
plt.figure(figsize=(10, 6)) sns.barplot(x=banner\_clicks.index, y=banner\_clicks.values, palette='viridis')   
plt.title('Impact of Ad Size on Number of Clicks')   
plt.xlabel('Banner Size')   
plt.ylabel('Total Clicks')   
plt.xticks(rotation=45)   
plt.show()

Question 3: Which publisher spaces (placements) yielded the highest number of displays and clicks?

placement\_displays\_clicks = df\_cleaned.groupby('placement').agg({'displays': 'sum', 'clicks': 'sum'}).sort\_values(by='displays', ascending=False)   
print(placement\_displays\_clicks)

Question 4: Is there a correlation between the cost of serving ads and the revenue generated from clicks?

cost\_revenue\_corr = df\_cleaned[['cost', 'revenue']].corr().iloc[0, 1]   
print(cost\_revenue\_corr)   
plt.figure(figsize=(8, 6))   
sns.heatmap(df\_cleaned[['cost', 'revenue']].corr(), annot=True, cmap='coolwarm', center=0)   
plt.title('Correlation Between Cost and Revenue')   
plt.show()

Question 5: What is the average revenue generated per click for Company X during the campaign period?

average\_revenue\_per\_click = df\_cleaned['revenue'].sum() / df\_cleaned['clicks'].sum()   
print(average\_revenue\_per\_click)

Question 6: Which campaigns had the highest post-click conversion rates?  
df\_cleaned['conversion\_rate'] = df\_cleaned['post\_click\_conversions'] / df\_cleaned['clicks'] top\_conversion\_campaigns = df\_cleaned.groupby('campaign\_number')['conversion\_rate'].mean().sort\_values(ascending=False) print(top\_conversion\_campaigns)   
plt.figure(figsize=(12, 6)) top\_conversion\_campaigns.plot(kind='bar', color='skyblue') plt.title('Campaigns with Highest Post-Click Conversion Rates')   
plt.xlabel('Campaign Number')   
plt.ylabel('Average Conversion Rate')   
plt.xticks(rotation=45)   
plt.show()

Question 7: Are there any specific trends or patterns in post-click sales amounts over time?

post\_click\_sales\_trend = df\_cleaned.groupby('date')['post\_click\_sales\_amount'].sum() print(post\_click\_sales\_trend)   
plt.figure(figsize=(12, 6)) post\_click\_sales\_trend.plot(kind='line', marker='o', color='green')   
plt.title('Trends in Post-Click Sales Amounts Over Time') plt.xlabel('Date')   
plt.ylabel('Total Post-Click Sales Amount')   
plt.grid(True)   
plt.show()

Question 8: How does the level of user engagement vary across different banner sizes?

engagement\_banner = df\_cleaned.groupby(['banner', 'user\_engagement'])['displays'].sum().unstack().fillna(0) print(engagement\_banner)   
plt.figure(figsize=(12, 8))   
sns.heatmap(engagement\_banner, annot=True, cmap='viridis') plt.title('Variation of User Engagement Across Different Banner Sizes')   
plt.xlabel('User Engagement')   
plt.ylabel('Banner Size')   
plt.show()

Question 9: Which placement types result in the highest post-click conversion rates?

placement\_conversion\_rate = df\_cleaned.groupby('placement')['conversion\_rate'].mean().sort\_values(ascending=False)

print(placement\_conversion\_rate)

Question 10: Can we identify any seasonal patterns or fluctuations in displays and clicks throughout the campaign period?

displays\_clicks\_trend = df\_cleaned.groupby('date').agg({'displays': 'sum', 'clicks': 'sum'})

print(displays\_clicks\_trend)

Question 11: Is there a correlation between user engagement levels and the revenue generated?

engagement\_revenue\_corr = df\_cleaned.groupby('user\_engagement').agg({'revenue': 'sum', 'displays': 'sum'})

engagement\_revenue\_corr['corr'] = engagement\_revenue\_corr.corr().iloc[0, 1]

print(engagement\_revenue\_corr)

Question 12: Are there any outliers in terms of cost, clicks, or revenue that warrant further investigation?

outliers\_cost = df\_cleaned[['cost', 'clicks', 'revenue']].apply(lambda x: np.abs(x - x.mean()) / x.std()).max()

print(outliers\_cost)

plt.figure(figsize=(12, 6))

outliers\_cost.plot(kind='bar', color='orange')

plt.title('Outliers in Cost, Clicks, and Revenue')

plt.xlabel('Metric')

plt.ylabel('Z-Score')

plt.show()

Question 13: How does the effectiveness of campaigns vary based on the size of the ad and placement type?

campaign\_banner\_effectiveness = df\_cleaned.groupby(['campaign\_number', 'banner', 'placement']).agg({

'displays': 'sum',

'clicks': 'sum',

'revenue': 'sum',

'conversion\_rate': 'mean'

}).sort\_values(by='revenue', ascending=False)

print(campaign\_banner\_effectiveness)

plt.figure(figsize=(14, 8))

campaign\_banner\_effectiveness[['displays', 'clicks', 'revenue']].plot(kind='bar', stacked=True)

plt.title('Effectiveness of Campaigns Based on Ad Size and Placement')

plt.xlabel('Campaign Number and Banner Size')

plt.ylabel('Total')

plt.xticks(rotation=45)

plt.legend(loc='upper left')

plt.show()

Question 14: Are there any specific campaigns or banner sizes that consistently outperform others in terms of ROI?

df\_cleaned['roi'] = df\_cleaned['revenue'] / df\_cleaned['cost']

top\_roi\_campaigns = df\_cleaned.groupby(['campaign\_number', 'banner']).agg({'roi': 'mean'}).sort\_values(by='roi', ascending=False)

print(top\_roi\_campaigns)

Question 15: What is the distribution of post-click conversions across different placement types?

placement\_conversion\_distribution = df\_cleaned.groupby('placement')['post\_click\_conversions'].sum().sort\_values(ascending=False)

print(placement\_conversion\_distribution)

Question 16: Are there any noticeable differences in user engagement levels between weekdays and weekends?

df\_cleaned['weekday'] = df\_cleaned['date'].dt.weekday

weekend\_engagement = df\_cleaned[df\_cleaned['weekday'] >= 5].groupby('user\_engagement')['displays'].sum()

weekday\_engagement = df\_cleaned[df\_cleaned['weekday'] < 5].groupby('user\_engagement')['displays'].sum()

print(weekend\_engagement, weekday\_engagement)

plt.figure(figsize=(12, 6))

plt.plot(weekend\_engagement.index, weekend\_engagement.values, label='Weekends', marker='o')

plt.plot(weekday\_engagement.index, weekday\_engagement.values, label='Weekdays', marker='o')

plt.title('User Engagement Levels on Weekdays vs. Weekends')

plt.xlabel('User Engagement Level')

plt.ylabel('Number of Displays')

plt.legend()

plt.grid(True)

plt.show()

Question 17: How does the cost per click (CPC) vary across different campaigns and banner sizes?

df\_cleaned['cpc'] = df\_cleaned['cost'] / df\_cleaned['clicks']

cpc\_campaign\_banner = df\_cleaned.groupby(['campaign\_number', 'banner'])['cpc'].mean().unstack().fillna(0)

print(cpc\_campaign\_banner)

plt.figure(figsize=(14, 8))

cpc\_campaign\_banner.plot(kind='bar', stacked=True, colormap='viridis')

plt.title('Cost Per Click (CPC) Across Different Campaigns and Banner Sizes')

plt.xlabel('Campaign Number')

plt.ylabel('Average CPC')

plt.xticks(rotation=45)

plt.legend(title='Banner Size')

plt.grid(True)

plt.show()

Question 18: Are there any campaigns or placements that are particularly cost-effective in terms of generating post-click conversions?

df\_cleaned['cost\_effectiveness'] = df\_cleaned['post\_click\_conversions'] / df\_cleaned['cost']

campaign\_placement\_effectiveness = df\_cleaned.groupby(['campaign\_number', 'placement'])['cost\_effectiveness'].mean().sort\_values(ascending=False)

print(campaign\_placement\_effectiveness)

plt.figure(figsize=(14, 8))

campaign\_placement\_effectiveness.plot(kind='bar', color='teal')

plt.title('Cost-Effectiveness of Campaigns and Placements in Generating Post-Click Conversions')

plt.xlabel('Campaign Number and Placement')

plt.ylabel('Cost Effectiveness')

plt.xticks(rotation=45)

plt.show()

Question 19: Can we identify any trends or patterns in post-click conversion rates based on the day of the week?

df\_cleaned['day\_of\_week'] = df\_cleaned['date'].dt.day\_name()

conversion\_rates\_by\_day = df\_cleaned.groupby('day\_of\_week')['conversion\_rate'].mean().reindex(['Monday', 'Tuesday', 'Wednesday', 'Thursday', 'Friday', 'Saturday', 'Sunday'])

print(conversion\_rates\_by\_day)

plt.figure(figsize=(12, 6))

conversion\_rates\_by\_day.plot(kind='bar', color='coral')

plt.title('Post-Click Conversion Rates by Day of the Week')

plt.xlabel('Day of the Week')

plt.ylabel('Average Conversion Rate')

plt.xticks(rotation=45)

plt.grid(True)

plt.show()

Question 20: How does the effectiveness of campaigns vary throughout different user engagement types in terms of post-click conversions?

campaign\_engagement\_conversion = df\_cleaned.groupby(['campaign\_number', 'user\_engagement'])['conversion\_rate'].mean().unstack().fillna(0)

print(campaign\_engagement\_conversion)

plt.figure(figsize=(14, 8))

campaign\_engagement\_conversion.plot(kind='bar', stacked=True, colormap='plasma')

plt.title('Effectiveness of Campaigns Across Different User Engagement Types')

plt.xlabel('Campaign Number')

plt.ylabel('Average Conversion Rate')

plt.xticks(rotation=45)

plt.legend(title='User Engagement')

plt.grid(True)

plt.show()

**Conclusion**

This report presents a comprehensive analysis of the online advertising performance of Company X. Key findings include trends in user engagement, the impact of ad size, placement effectiveness, and correlations between cost and revenue. These insights will help guide future advertising strategies.